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Types of corn suited to Mass. conditions.

P.H. Smith

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TYPES OF CORN SUITED TO MASSACHUSETTS CONDITIONS.

A THESIS

Submitted to the Faculty of the

Massachusetts Agricultural College

for the degree of

MASTER OF SCIENCE

By

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Types of Corn Suited to Massachusetts Conditions.

Introduction.

Since 1903 experiments have been in progress with corn to determine, if possible, those varieties, or rather types, best suited to Massachusetts conditions. With this end in view, the total yield of dry matter per acre, digestibility, the relative proportions and in some cases the composition of the various parts of the plant (stalk, leaf, ear and husk) and the relation of the stage of development to the relative proportion of different parts as effecting the food value have been carefully studied.

Soil, Cultivation, Size of Plots, Fertilizers used.

With the exception of the Eureka and Pride of the North varieties tested in 1904, the corn was grown upon one-twentieth acre plots (30x73 feet) rows running east and west. The soil consisted of a light sandy loam such as might be considered satisfactory corn land; it was liberally and uniformly fertilized as follows:

1906. Leaming and Pride of the North grown.

Fertilizers used per acre:

200 lbs. high grade sulphate of potash, equivalent to about 100 lbs. potash,

300 " acid phosphate, equivalent to about 45 lbs. available phosphoric acid,

200 " nitrate of soda, equivalent to about 30 lbs. nitrogen,

200 " dry ground fish, equivalent to about 16 lbs. organic nitrogen,

The corn planted in 1906 produced an exceptionally fine crop. This was evidently due to very favorable weather conditions. The yield may also have been favored to some extent by the growth of medium green soy beans on the same plots the preceding year..

1907. Leaming and Pride of the North grown.

Fertilizers used per acre:

200 lbs. high grade sulphate of potash, equivalent to about 100 lbs. potash,

500 " phosphatic slag, equivalent to about 75 lbs. available phosphoric acid,

200 " nitrate of soda, equivalent to about 30 lbs. nitrogen,

300 " dry ground fish, equivalent to 24 lbs. organic nitrogen.

1908. Sanford, Longfellow, Rustler, Early Mastodon, Klondike, Red Cob Silage and White Cap Yellow grown.

Fertilizers used per acre:

300 lbs. high grade sulphate of potash, equivalent to about 150 lbs. potash,

500 " acid phosphate, equivalent to about 75 lbs. available phosphoric acid,

200 " nitrate of soda, equivalent to about 30 lbs. nitrogen,

500 " dry ground fish, equivalent to about 40 lbs. organic nitrogen,

1909. Twitchell's, Rustler, Brewers, Early Mastodon, White Cap Yellow, Wing's Improved White Cap grown.

Fertilizers used per acre:

300 lbs. high grade sulphate of potash, equivalent to about 150 lbs. potash,

700 " acid phosphate, equivalent to about 105 lbs. available phosphoric acid,

200 " nitrate of soda, equivalent to about 30 lbs. nitrogen,

500 " dry ground fish, equivalent to about 40 lbs. organic nitrogen.

1910. Rustler, Brewers, Longfellow, Eureka grown.

Fertilizers used per acre:

300 lbs. high grade sulphate of potash, equivalent to about 150 lbs. potash,

700 " acid phosphate, equivalent to about 105 lbs. available phosphoric acid,

200 " nitrate of soda, equivalent to about 30 lbs. nitrogen,

500 " dry ground fish, equivalent to about 40 lbs. organic nitrogen.

A larger amount of fertilizer was added during the last few years of the experiment in order to insure the maximum development of the crop. The yield of corn planted on the same land for several successive years is likely to decrease, and it was thought that the additional amount of plant food applied would in a measure check this shrinkage.

The chemicals were mixed, sown broadcase and harrowed in just before the corn was planted. While the application of commercial fertilizer was liberal, it is believed that larger yields might have been secured, in some cases at least, if more organic matter, either through the medium of barnyard manure or as a cover crop

to be plowed under in the spring, had been added to the soil.

The Pride of the North and Eureka corn grown in 1904 were not planted on the twentieth-acre plots but was grown on one-half acre plots in an adjoining field. In this case the rows ran north and south and the corn was sown in drills and thinned to one plant to the foot at the time of hoeing. It was fertilized with cow manure at the rate of six cords to the acre and the land well fitted.

The corn grown in twentieth-acre plots was planted in hills 3½ x 3½ feet in the hill and thinned to four plants at the time of hoeing. It was seeded May 20-25 and harvested September 15, which is about as late as it is advisable to allow corn to stand and be safe from frosts.

Description of Varieties.

Twitchell's. A small growing yellow flint bred in Maine. On account of its early maturing qualities (with us in the vicinity of August 20) it may be grown as far north as corn culture can be considered profitable. It has a short stalk of small diameter and a good sized ear, in some cases two ears being noted on each stalk. It cannot be considered satisfactory for forage or silage where larger varieties will mature.

Sanford White. A white flint corn quite like Longfellow in general appearance, size of plant and time of ripening.

Longfellow. An old established yellow flint variety extensively grown in Massachusetts. It is one of the best of the yellow flint varieties.

Pride of the North. One of the earliest and apparently most satisfactory yellow dent varieties for Massachusetts. It does not usually make as large a growth as the Leaming but in an average season will reach maturity.

Rustler.Minnesota Dent. A white dent corn believed to have been first raised in Massachusetts on the Agricultural College Farm from seed procured in Minnesota. It has given uniformly good results and can be considered a satisfactory dent variety in spite of the fact that the ears do not usually develop well at the tip. It is believed that this corn can be greatly imrpoved by careful breeding.

Leaming. Yellow dent. Somewhat like the Pride of the North but makes a larger growth and matures a little later. It is extensively grown for silage in Massachusetts and unless the season is unusually backward, will mature sufficiently for this purpose.

Brewers. Yellow dent. This is believed to be a western dent variety improved by N. H. Brewer of Higganum, Connecticut. Mr. Brewer has raised enormous crops by following an intensive system of fertilization and cultivation. We have not been successful in ripening it on the Station Farm. At the time of cutting (September 15) the ears were hardly in the milk and consequently not suitable to harvest.for grain. It evidently needs a somewhat longer growing season than is usually experienced in the vicinity of Amherst.

Early Mastodon. Yellow dent. Bred by C. S. Clark of Ohio. A large growing variety evidently rather too late for grain in Massachusetts.

Klondike. Yellow dent. Quite like the Early Mastodon in appearance but noticeably later and unsuited to New England conditions.

Red Cob Silage. White dent. Medium late.

White Cap Yellow Dent. Resembles Leaming in size but matures rather later. Fairly satisfactory for silage.

Wings Improved White Cap. Originated by J. E. Wing of Ohio. Some of the stalks bore two ears. It would probably form a very satisfactory variety in the middle western states but the season is not sufficiently long to enalbe it to reach maturity in New England.

Eureka White Dent. A large growing southern variety. It reaches a height of some 13 or more feet and has very coarse stalks. It has never matured in Amherst. The ears set very high on the stalk and the kernels are forming by September 15th.

YIELD PER ACRE OF ENTIRE CORN PLANT.

Year.	Variety.	Condition.	Total Yield. lbs.	Dry Matter. lbs.
1909.	Twitchell's	Mature, past time for cutting.	13,800	4,236
1908.	Sanford,	Mature,	28,400	8,148
1908.	Longfellow,	Mature,	34,960	8,981
1910.	Longfellow,	Mature,	25,400	6,480
1904.	Pride of the North,	Fairly ripe, kernels glazing,	27,800	6,253
1906.	Pride of the North,	Mature,	42,600	11,664
1907.	Pride of the North,	In milk, not quite ripe,	28,500	5,141
1908.	Rustlers Minn. Dent,	Mature,	23,067	7,843
1909.	Rustlers Minn. Dent.	Mature,	27,100	5,328
1910.	Rustlers Minn. Dent,	Mature,	22,400	6,772
1906.	Leaming,	Mature,	51,560	12,307
1907.	Leaming,	In milk, not quite ripe,	28,200	5,144
1909.	Brewers,	In milk, green,	35,100	6,286
1910.	Brewers,	In milk, green,	28,100	7,226
1908.	Early Mastodon,	In milk to dent stage, green,	39,320	9,488
1909.	Early Mastodon,	In milk to dent stage, green,	36,220	6,436
1908.	Klondike,	Green and poorly eared,	37,340	9,069
1908.	Red Cob Silage,	In milk to dent stage, green,	43,500	11,210
1908.	White Cap Yellow,	In milk to dent stage, green,	35,300	11,038
1909.	White Cap Yellow ,	In milk to dent stage, green,	24,900	5,784
1909.	Wings Imp. White Cap,	In milk, green,	28,300	5,671
1904.	Eureka,	Immature, Kernels scarcely formed	40,800	6,671
1910.	Eureka.	Immature, ears just forming,	43,800	9,044

The preceding table shows that the total yield per acre as cut and also the total yield of dry matter. The entire for each twentieth-acre plot was cut and immediately hauled to the barn and weighed. The dry matter was determined by taking a representative sample at the time of harvesting, running it through a cutter, subsampling, placing the latter in a glass stoppered jar and drying a definite weight at 100° C.

The Twitchell corn was well matured in spite of the unfavorable season and although the 4236 pounds of dry matter were much less than for any of the other varieties, it probably represented a fair average yield of its kind. The yields of Longfellow and Sanford both grown in favorable seasons may be considered normal in amount. The season of 1908 was rather better than 1910 which would probably account for the larger yield of Longfellow corn in the former year.

Pride of the North was grown during three seasons, The seasons of 1904 and 1907 were both unfavorable while 1906 was especially satisfactory, and in this year it yielded approximately twice as much dry matter as was secured in the average crop of the other two seasons.

Rustler also grown for three seasons showed a reasonably uniform dry matter content with the highest yield in the more favorable season (1908).

Leaming grown in a favorable and unfavorable season yielded over twice as much dry matter in the favorable year.

Brewers Dent which evidently needs a longer growing season for its maturity than usually is to be had in Massachusetts, did not show a very decided variation between the two years.

Early Mastodon and White Cap Yellow both grown in 1908 and 1909 showed the larger yields in 1908, the more favorable year.

Klondike and Red Cob Silage were both grown in 1908 a favorable year. Neither ripened satisfactorily but showed good yields of dry matter. The former was noticeably immature when harvested.

Wings Improved White Cap grown in 1909 - a poor corn year - did not yield well and evidently needs a longer growing season.

Eureka, grown in 1909 and 1910, showed the better yield in 1910. In neither case was the corn well matured nor did it show a larger yield of dry matter than some of the smaller varieties that would show a very much larger percentage of mature ears.

The total yield of dry matter rather than the green material gives a much better indication of the value of the crop for feeding purposes. A green immature crop will often furnish a large apparent yield but contains an excessive amount of water. This fact is especially evidenced by the Eureka and Klondike which, while they gave high yields of green material, did not show the highest production of dry matter.

Morrow* as a result of four years observations states that in no year was there more than half the total amount of dry matter when the plant had reached its full height, and not more than 75 percent of the maximum when the ears were in dough stage. Ladd** as a result of a two years experiment found that the greatest weight of green fodder to be between the period of full silking and milky stage of kernel and that while the total weight diminished after this date the total dry matter increased. Our own results corroborated by those of other investigators, indicate that such varieties as the Twitchell, Sanford, Longfellow, Pride of the North (in one case)

* Bulletin 25, Illinois Experiment Station p.200.

** Eighth Annual Report New York Experiment Station, p. 90.

and Rustler can be considered as having reached a maximum weight in dry matter under the conditions in which they were grown. The remaining varieties with the exception of the Eureka would surely have increased in dry matter and decreased in total weight had their growing season been longer, while the Eureka would probably have increased in both total weight and dry matter. On account of their high water content and less mature condition the last eight varieties in the preceding table cannot be considered as valuable pound for pound as the more mature types.

Effect of Season on Yield.

The following data taken from the Massachusetts Crop Report will show the weather conditions for the years during which the corn was grown.

1904. Season as a whole cool and dry which made corn unusually late and poorly ripened.

1906. Season as a whole warm especially in July and August. Good rainfall in June and July, hot and humid weather in August with warm dry weather the first part of September. The weather conditions were very favorable for corn and the crop ripened exceedingly well.

1907. Season as a whole hot and dry, August being the hottest month for 36 years. A late spring together with succeeding dry weather hindered the development of the crop which was below normal.

1908. Season variable with high temperature and rainfall at opportune times. July hot with little rain till the last part. August cool with plenty of rain. The early part of September dry and warm which hastened the development of the crop that was exceptionally good.

1909. Season as a whole dry and cool. The crop germinated well but the growth was checked by drought and cool weather to such an extent that in many cases the ears did not ripen in spite of no killing frosts until late.

1910. Season as a whole hot and dry. Rain at such times as to greatly benefit crop which was above normal and well matured.

The most striking feature brought out by the preceding table is the extreme variation in yield not only between different varieties but between the same varieties grown in different years. This point is well illustrated by Pride of the North grown in 1904, 1906 and 1907, the yield being a third more for 1906, a very favorable corn year. Morrow* found this to be the case in experiments conducted in Illinois and states that the rain and heat were more influential on the rate of growth than the difference in the variety of corn. It is believed that the total yield of dry matter can be affected by climatic conditions in two ways; a lack of rain at critical periods may cause the corn to ripen before it has obtained its maximum growth while a cold wet season will retard the growth of the crop so that it does not reach maturity in the growing season.

The data in the above table makes especially clear that:

1. The small varieties as represented by the Twitchell because of the relatively low yield of total dry matter are not economical for Massachusetts conditions.

2. The flint varieties such as Longfellow and Sanford and the medium dents - Rustlers and Pride of the North - are quite well suited for grain and also serve fairly well for silage.

3. The larger medium dents - including the Leaming, White Cap Yellow, Red Cob and Early Mastodon - give a very good yield of dry matter, and in average season bring their ears to the milk stage. All conditions considered, these varieties are rather preferable for silage purposes.

* Bulletin 31, Illinois Experiment Station p. 363.

4. The coarse late maturing varieties as represented by the Klondike, Wings Improved, Brewers, and particularly the Eureka while yielding a fair average amount of dry matter are not satisfactory because of their failure to mature; the resulting silage has been repeatedly shown by other observers as being watery, sour, and of less nutritive value.

5. The season has a marked influence upon the yield of the corn crop - the same variety of corn under otherwise identical conditions yielding from 50 to 100 percent more in a year particularly favorable to its growth.

COMPOSITION OF DIFFERENT VARIETIES OF CORN FODDER, (ENTIRE PLANT).
(As harvested).

Number of Analyses.	Variety.	Water. %	Protein. %	Fat. %	Nitrogen Free Extract. %	Fiber. %	Ash. %
1	Twitchell's	69.11	3.03	0.94	20.21	5.34	1.37
1	Sanford White,	71.31	1.97	0.75	19.03	5.78	1.16
1	Longfellow,	74.31	2.30	0.60	16.38	5.03	1.38
6	Pride of the North,	75.33	2.02	0.60	15.74	5.18	1.13
3	Rustlers White Dent,	71.62	2.17	0.68	18.36	5.94	1.23
4	Leaming,	76.85	1.77	0.47	14.21	5.60	1.10
2	Brewers,	81.35	1.82	0.27	10.90	4.72	0.94
3	Early Mastodon,	77.77	1.86	0.41	13.77	5.14	1.05
1	Klondike,	75.71	1.31	0.42	14.09	6.98	1.49
1	Red Cob Silage,	74.23	1.58	0.40	15.69	6.93	1.17
2	White Cap Yellow Dent,	72.75	2.17	0.50	17.38	6.02	1.18
2	Wings Improved White Cap,	80.39	1.72	0.32	12.06	4.53	0.98
1	Eureka,	82.58	1.63	0.27	9.26	4.78	1.08

COMPOSITION OF DIFFERENT VARIETIES OF CORN FODDER, (ENTIRE PLANT).
(Dry Matter).

Number of Analyses.	Variety.	Protein. %	Fat. %	Nitrogen Free Extract. %	Fiber. %	Ash. %
1	Twitchell's	9.82	3.05	65.43	17.28	4.42
1	Sanford White,	6.85	2.61	66.36	20.13	4.05
1	Longfellow,	8.96	2.34	63.77	19.56	5.37
6	Pride of the North,	8.18	2.43	63.08	21.01	4.58
3	Rustlers White Dent,	7.66	2.39	64.68	20.94	4.33
4	Leaming,	7.63	2.01	61.40	24.19	4.77
2	Brewers	9.75	1.43	58.43	25.33	5.06
3	Early Mastodon,	8.37	1.85	61.97	23.10	4.71
1	Klondike,	5.43	1.72	57.99	28.74	6.14
1	Red Cob Silage,	6.12	1.57	60.87	26.90	4.54
2	White Cap Yellow Dent,	7.96	1.83	63.78	22.10	4.33
2	Wings Improved White Cap,	8.75	1.65	61.48	23.10	5.02
1	Eureka,	9.34	1.54	55.52	27.41	6.19

The varieties of corn given in the preceding tabulation can be divided into four different groups according to their period of ripening.

1. Mature (Dents and Flints). Twitchell's, Sanford White, Longfellow, Pride of the North and Rustler.

2. Medium Mature. (Coarse Dents). Leaming, Early Mastodon, Red Cob Silage, and White Cap Yellow Dent.

3. Immature. (Very Coarse Dent). Brewers, Klondike, and Wings Improved White Cap.

4. Very Immature. (Very Coarse Dent). Eureka.

The average water content of the four groups was as follows:

Mature	74.34%
Medium Mature . . .	75.40%
Immature	79.15%
Very Immature . . .	82.58%

While there is a gradual diminution in the water content from the time that the ears are formed until maturity as shown by this table, the total dry matter gradually increases to maturity.*

It is not believed, that owing to individual variations, conclusions can be readily drawn relative to the chemical composition of the different varieties. By averaging the four groups previously given the following results are obtained:

* Ladd, New York Experiment Station Report 1889.

Dry Matter.

	Protein.	Fat.	Nitrogen free Extract.	Fiber.	Ash.
Mature,	8.29	2.56	64.81	19.78	4.55
Medium mature,	7.52	1.82	62.00	24.07	4.59
Immature,	7.97	1.60	59.30	25.72	5.41
Very immature,	9.34	1.54	55.52	27.41	6.19

The very green immature corn contains a larger relative percentage of protein but more of it in the amido form.[1] The fat and particularly the nitrogen free extract matter increase, the more mature the variety. This is to be expected for the corn is a carbohydrate plant and stores up large amounts of starch in the latter stages of its growth. As the starch increases the percentage of fiber and ash relatively decrease. The ash is always at its highest point in the early stages of development.

The preceding facts are substantiated by the investigations of Schweitzer[2] , Jordan[3], Ladd[4] and others.

The general conclusion can be drawn that the changes in chemical composition which the plant undergoes in its development are such that its maximum feeding value exists at its maturity.

1. Eighth Annual Report New York Experiment Station, p. 90.
2. Bulletin No. 9, Missouri Experiment Station.
3. Annual Report Maine Experiment Station, 1893.
4. Eighth Annual Report New York Experiment Station, 1899.

DIGESTIBILITY OF THE PLANT.

The digestibility of seven representative varieties of the entire plant was determined with sheep. The method followed in conducting such experiments is illustrated and described in detail elsewhere.[1] The entire data of the several experiments is to be found as a supplement to this paper - only the results in the form of digestion coefficients are given in this connection. Four sheep only being available, only two duplicate digestion trials could be completed in a single season. The method of procedure was as follows: Each experiment was begun about September fifth when the sheep received their first feeding. The corn was allowed to stand in the field; sufficient being cut for only two consecutive days. The entire digestion period lasted fourteen days, the first seven of which were preliminary. The corn was cut in two inch pieces before being fed. Two days feeding were weighed out in advance and samples taken for dry matter determinations and for complete chemical analysis. The difference between the amount and chemical composition of the fodder fed and the amount and chemical composition of the faeces excreted served as a basis for computing the amount digested and utilized by the animals.

1. Eleventh Report of the Massachusetts State Agricultural Experiment Station, pp. 126-149; also Twenty-second Report of the Massachusetts Agricultural Experiment Station, p. 84.

DIGESTION COEFFICIENTS.*

(Percent Dry Matter Digested).

Variety Corn.	Condition of crop at time of harvest.	Digestion Coefficients.					
		Dry Matter.	Pro-tein.	Fat.	Nitrogen free extract	Fiber.	Ash.
Pride of the North,	In dough to denting,	71	63	76	77	65	34
Pride of the North,	In dough to denting,	77	63	84	84	66	36
Rustler,	In dough to denting,	69	43	76	78	59	28
Leaming,	Corn in late milk,	70	60	76	77	61	36
Brewers,	Corn in milk,	72	69	68	77	69	46
Early Mastodon,	Corn in milk,	72	57	81	79	60	36
Wings Imp. White Cap,	Corn in milk,	70	63	70	76	65	39
Eureka,	Kernels just forming,	67	67	66	72	60	42
Pride of the North stover		54	45	64	54	60	31
Eureka stover,		54	48	67	53	59	45

* For figures in detail see Supplement.

A study of the above coefficients shows no wide variations in the relative digestibility of the several varieties. Naturally the larger the percentage of ear present the higher should be the digestibility of the entire plant, the grain having a much higher digestibility than the stalk. This in a general way is made clear by classifying the results according to the stage of growth. Corn that is immature and with ears partially formed may show nearly as high an absolute digestibility as a mature variety because of the soft incompletely developed stalks. If it had been possible to determine the net available energy of each variety according to the method employed by Kellner[1], those varieties having the mature ears would unquestionably have shown a much larger amount of energy than the less mature varieties.

Attention may also be called to the variation in the percentage of nitrogen free extract of the several varieties.[2] With one exception[3] the digestibility varies to a limited extent inversely with the percentage of nitrogen free extract or otherwise explained, the larger the percentage of extract or starchy matter present, the higher the digestibility of the corn plant.

A division and tabulation of the results according to the stage of growth of the varieties gives us the following results.[4]

1. The Scientific Feeding of Animals, pp. 48-50.
2. See tabulated analyses in supplement.
3. In case of Rustler Dent rather more was fed than the animals could well utilize which explains the low coefficient for this variety.
4. Omitting coefficients for Rustler Dent from the mature varieties.

		Dry Matter.	
	Average Yield per acre.	Percent Digested.	Pounds per acre Digested.
Mature	7686	74	5688
Medium mature,	8344	71	5924
Immature,	6394	71	4540
Very immature,	7858	67	5265

It would appear from the above that the larger growing varieties such as Leaming, Red Cob, Early Mastodon and White Cap will produce rather more dry and digestible matter than do the medium dent or flints as typified in the Longfellow or Rustler and the former varieties on the whole are to be given the preference for silage purposes. It is questionable, however, if they furnish any more final nutritive effect (net available energy) than do the varieties that will thoroughly mature by the middle of September. The percentage of dry matter digested on the other hand is in favor of the mature varieties. The extremely late varieties such as the Eureka and Klondike are not at all suited to New England conditions.

Experiments were made with a sample of Pride of the North and a sample of Eureka corn stover during the year of 1904; the two lots proving to be equally digestible. The former variety of stover contained 18.13 percent of water when sampled (December 27) and the latter contained 59.92 percent (February 29). Both samples had been stored in the barn since late autumn. When drawn from the field the former contained 37.84 percent and the latter 68.92 percent of water. The Eureka stover, because of its coarse immature condition retained the moisture to a much greater extent than did the fully matured corn.

PROPORTIONS AND COMPOSITION OF PARTS.

(a) Proportions at Time of Cutting (100 Pounds).

Year.	Variety.	Stalks.	Leaves.	Husks.	Ears.
1909.	Twitchells	27	26	10	37
1908.	Sanford White	45	20	11	24
1908.	Longfellow	48	21	10	21
1910	Longfellow	38	25	9	28
1904	Pride of the North	47	20	11	22
1906	Pride of the North	40	17	12	31
1907	Pride of the North	52	16	14	18
1908	Rustler	46	19	7	28
1909	Rustler	41	14	15	30
1910	Rustler	40	19	9	32
1906	Leaming	48	19	11	22
1907	Leaming	52	17	12	19
1909	Brewers	51	17	13	19
1910	Brewers	53	17	10	20
1908	Early Mastodon	52	19	9	20
1909	Early Mastodon	50	18	12	20
1908	Klondike	62	19	9	10
1908	Red Cob Silage	53	17	12	18
1908	White Cap Yellow	46	19	11	24
1909	White Cap Yellow	50	16	12	22
1909	Wings Imp. White Cap	52	19	10	19
1904	Eureka	64	22	7	7
1910	Eureka	62	21	7	10

(b). Proportions in Dry Matter. (100 Pounds).

Year.	Variety.	Stalks.	Leaves.	Husks.	Ears.
1909	Twitchell's	15	21	9	55
1908	Sanford White	35	20	10	35
1908	Longfellow	34	18	9	39
1910	Longfellow	23	21	7	49
1904	Pride of the North	37	18	9	36
1906	Pride of the North	28	14	9	49
1907	Pride of the North	50	19	11	20
1908	Rustler	33	19	7	41
1909	Rustler	32	13	12	43
1910	Rustler	30	17	8	45
1906	Leaming	41	19	9	31
1907	Leaming	48	20	10	22
1909	Brewers	51	20	12	17
1910	Brewers	47	20	10	23
1908	Early Mastodon	44	19	9	28
1909	Early Mastodon	47	21	11	21
1908	Klondike	59	22	7	12
1908	Red Cob Silage	50	19	11	20
1908	White Cap Yellow	38	19	10	33
1909	White Cap Yellow	47	19	11	23
1909	Wings Imp. White Cap	52	23	9	16
1904	Eureka	63	25	6	6
1910	Eureka	59	28	6	6
	Average	42	20	9	29

Condition of Crop when cut and Character of Season.

1904. Poor corn year. Varities grown Pride of the North and Eureka. In spite of the unfavorable season Pride of the North was fairly ripe when cut and contained a fair proportion of ear. The Eureka was quite immature with ears just forming.

1906. An exceptionally favorable corn year. Varieties grown Pride of the North and Leaming. Both matured, gave a large total yield and showed a noticeably large proportion of ears.

1907. Poor corn year. Varieties grown Pride of the North and Leaming. Neither variety did as well as in 1906 and the proportion of ear was much less.

1908. Satisfactory corn year. Varieties grown Sanford White, Longfellow, Rustler, Early Mastodon, Klondike, Red Cob Silage and White Cap Yellow. Of these the first three were fully developed when cut, and showed a larger development of ear than did the last four which were in the milk to denting stage. White Cap Yellow was the best developed of the last named varieties and showed a fair proportion of ear.

1909. Poor corn year. Varieties grown Twitchell's, Rustler, Brewers, Early Mastodon, White Cap Yellow, Wings Improved White Cap. The first two varieties matured. The Twitchell, a very small variety, has a short stalk with a long ear setting low on the stalk. It showed the largest proportion of ear of any variety raised. The last three varieties were in milk when cut.

1910. Favorable corn year. Varieties - Longfellow, Rustler, Brewers, Eureka. The first two varieties were mature when cut. Brewers was in milk and the ears just forming on the Eureka.

It will be observed that in many cases the proportion of the several parts differ in the green stage and on the dry matter basis. Thus Twitchell's shows 27 percent of stalk when cut and only 15 percent when all of the water is eliminated. Sanford White shows 24 percent of ears when cut and 35 percent in dry matter.

The remarks which follow refer to the proportions of the parts on the basis of dry material. In general it may be said that there

is a wide difference between the proportion of stalks and ears; the difference between the leaves and husks is less marked.

A decided difference is noted between the same variety grown in different years. This variation is evidently due to some extent to the stage of maturity of the plant when cut and also to unfavorable conditions, which checked the development of the ear. The stalks and ears form practically 70 percent of the dry matter of the plant. The leaves and husks 30 percent. From the data at hand the inference can be drawn that this is an inherent characteristic of the maize plant. While other investigators[1] have determined the relative proportions of the plant, it is believed that this fact has not before been noticed.

Those coarse varieties maturing late naturally have less ear and a correspondingly larger proportion of stalk. Note the mature varieties including the Longfellow with an average of 28 percent of stalk and 44 percent of ears, the Pride of the North with an average of 38 percent of stalk and 35 percent of ears, the Rustler with 32 percent of stalk and 35 percent of ears, against the later maturing varieties such as the Brewers with 49 percent of stalk and 19 percent of ears, the Leaming with 44 percent of stalk and 26 percent of ears, and finally the Eureka with 61 percent of stalk and 6 percent of ears. On the whole the proportion of leaves and husks do not vary widely in any of the varieties, averaging 20 percent for the leaves and 9 percent for the husks. The Eureka shows rather more leaf and correspondingly less husk than the other varieties; in fact this variety as cut was largely

1. Schweitzer, Bulletin No. 9, Missouri Experiment Station.
   Caldwell, Bulletin 7-11, Report of 1890, p. 30-43, Penn. Experiment Station.
   Bulletin 21, Iowa Experiment Station.

stalk and leaf.

The following general conclusions can be drawn:

1. The stalks and ears form substantially 70 percent of the entire maize plant.

2. The small early maturing varieties of which the Twitchell is a type show an exceptionally large proportion of ears.

3. The mature medium varieties average 33 percent of stalk and 37 percent of ears.

4. The coarser less mature varieties show 45 percent stalk and 26 percent ears.

5. The very coarse immature varieties (excepting Eureka) show 52 percent stalks and 17 percent of ears.

6. Most of the varieties have in the vicinity of 20 percent leaves and 10 percent ears.

The above conclusions are for corn grown in Massachusetts and cut about September 15th. These conclusions might not hold especially for the larger immature varieties had they been ripe at the time of cutting.

AVERAGE COMPOSITION OF PARTS.

Number of Analyses	Variety	Water	Dry Matter				
			Protein.	Fat.	Nitrogen Free Extract.	Fiber.	Ash.
		%	%	%	%	%	%
	Stalks						
2	Pride of the North	79.84	4.04	0.89	56.52	32.91	5.64
2	Leaming	80.97	3.91	0.94	58.94	31.56	4.65
1	Eureka	83.08	4.80	1.07	52.94	35.77	5.42
	Leaves						
2	Pride of the North	76.28	13.99	3.39	48.89	24.06	9.67
2	Leaming	76.53	13.65	3.03	48.89	25.16	9.27
1	Eureka	81.17	14.53	2.43	45.63	28.43	8.98
	Husks						
2	Pride of the North	77.49	5.14	1.36	62.23	27.98	3.29
2	Leaming	81.87	6.77	1.50	61.69	26.74	3.30
1	Eureka	85.35	8.66	1.46	62.22	24.64	3.02
	Ears						
2	Pride of the North	56.54	9.53	3.73	75.50	9.46	1.78
2	Leaming	71.77	9.56	2.90	71.48	13.82	2.24
1	Eureka	86.91	12.00	1.44	63.84	19.47	3.25

While the analyses are not sufficient in number to enable one to draw any positive conclusions, attention may be called to a few of the more striking facts.

Stalks. A comparatively low percentage of both protein and fat is noted in the stalks of all the several kinds. The proportion of extract matter is lowest in the Eureka and the fiber percentage the highest.

Leaves. The protein percentage is highest in the leaves of all varieties including the mature Pride of the North. Naturally the fiber percentage is less in the leaves than in the stalks while the percentage of ash is noticeably high and quite constant for the three types. The leaves of the three varieties analyzed resemble each other quite closely in the proportion of all of the several groups of constituents.

Husks. The one noticeable difference in the case of the husks of the several varieties consists in the low protein content in the Pride of the North and the high protein content of the Eureka. This is, of course, due to the fact that the ears of the latter were in the formative stage while those of the former had matured and the protein had entered into the kernel. The fiber content of the Pride of the North was somewhat higher than that contained in the Eureka which is explained on similar grounds.

Ears. The composition of the ears of the three varieties indicate a very immature condition on the part of the Eureka - high protein and fiber, and low carbohydrates and fat - and a reasonably mature condition of the ears yielded by the Pride of the North and Leaming.

RELATIVE PROPORTIONS OF GRAIN AND COB.

Ten representative ears of corn were selected at the time of husking from the crops of 1908 and 1909 and preserved for analysis. The corn and cob were weighed separately at the time of shelling, dry matter determinations made and the percentage of cob and kernel determined.

WEIGHTS OF TEN AVERAGE EARS WITH PROPORTION OF

KERNEL AND COB IN DRY MATTER.

Variety	Condition when cut.	Dry Matter, pounds.			Dry Matter, per cent.	
		10 ears.	Kernel.	Cob.	Kernel.	Cob.
Twitchell's	Mature	3.37	2.93	0.44	86.9	13.1
Sanford White	Mature	3.37	2.65	0.72	78.6	21.4
Longfellow	Mature	3.53	2.95	0.58	83.6	16.4
Rustler	Mature	4.71	4.08	0.63	86.6	13.4
Rustler	Mature	4.87	4.23	0.64	86.9	13.1
Average		3.97	3.37	0.60	84.5	15.5
Brewers	In milk	4.29	3.57	0.72	83.2	16.8
Early Mastodon	In milk	4.05	3.37	0.68	83.2	16.8
Early Mastodon	In milk	5.48	4.55	0.93	83.0	17.0
Klondike	In milk	3.60	2.66	0.94	73.9	26.1
Red Cob Silage	In milk	4.37	3.59	0.78	82.2	17.8
White Cap Yellow	In milk	3.70	3.12	0.58	84.3	15.7
White Cap Yellow	In milk	3.71	3.11	0.60	83.8	16.2
Wings Imp. White Cap	In milk	4.14	3.39	0.75	81.9	18.1
Average		4.17	3.42	0.75	81.9	18.1

Wide variations were noted depending upon stage of ripeness. The Twitchell, a long eared and early maturing flint, showed the smallest percentage of cob (13.1) and the Klondike, a quite immature dent, the largest amount of cob (26.1). The average of the several mature types was 15.5 percent cob, and 84.5 percent kernel while the average for the less mature varieties was 18.1 for cob and 81.9 for kernel. If the less mature varieties had been grown in a climate favorable to their complete maturity, it is probable that they would have shown equally as favorable a proportion of cob and kernel.

The weight of the Massachusetts legal bushel in case of shelled corn is 56 pounds and for a bushel of ears 70 pounds. This allows 14 pounds or 20 percent for the cob. With but two exceptions the samples tested contained less than 20 percent cob in dry matter. Assuming that the standard of 70 pounds per bushel for corn was based upon the average of a large number of trials, is it not possible that the corn crop has been improved since the time that such a standard was adopted and that corn is now being grown that contains relatively less cob and more kernel than formerly.

The results of these trials are substantiated by work done by the author in connection with corn grown for the Bowker prize in 1910. The proportions of corn and cob in dry matter in ten representative ears of nine varieties was determined with the following results:

		Percent Grain.	Percent Cob.
1.	Flint	83.7	16.3
2.	"	84.8	15.2
3,	"	85.8	14.2
4.	"	78.7	21.3
5.	"	83.6	16.4
6.	"	84.6	15.4
	Average	83.5	16.5
7.	Dent	85.0	15.0
8.	"	80.7	19.3
9.	"	83.9	16.1
	Average	83.2	16.8

COMPOSITION OF GRAIN AND COB.

During the seasons of 1908 and 1909 samples of corn kernels were analyzed with the following results:

ANALYSES OF GRAIN.

(Dry Matter).

Year.	Variety.	Condition.	Protein. %	Fat. %	Nitrogen Free Extract. %	Fiber. %	Ash. %	Starch. %
1909	Twitchell's	Mature	11.30	5.12	80.49	1.58	1.51	67.54
1908	Sanford White	Mature	10.92	5.22	80.83	1.53	1.50	71.35
"	Longfellow	Mature	10.80	5.46	80.72	1.43	1.59	70.86
"	Rustler	Mature	9.55	4.44	82.79	1.77	1.45	72.84
1909	Rustler	Mature	9.56	4.55	82.33	1.41	1.52	70.00
"	Brewers	In milk	9.64	3.97	81.99	2.70	1.70	67.27
1908	Early Mastodon	In milk	9.22	4.62	82.29	2.33	1.54	72.98
1909	Early Mastodon	In milk	9.69	4.36	82.06	2.21	1.68	68.39
1908	Klondike	In milk	10.81	4.40	80.73	2.27	1.79	71.48
"	Red Cob Silage	In milk	10.69	3.61	81.80	2.33	1.57	72.70
"	White Cap Yellow	In milk	10.30	3.93	82.13	2.09	1.55	73.13
1909	White Cap Yellow	In milk	9.06	4.42	82.77	2.24	1.51	69.16
"	Wings Imp. White Cap	In milk	10.21	4.35	81.18	2.52	1.74	67.90

ANALYSES OF GRAIN.

(Dry Matter).

Year.	Variety.	Condition.	Protein. %	Fat. %	Nitrogen Free Extract. %	Fiber. %	Ash. %	Starch. %
1909	Twitchell's	Mature	11.30	5.12	80.49	1.58	1.51	67.54
1908	Sanford White	Mature	10.92	5.22	80.83	1.53	1.50	71.35
"	Longfellow	Mature	10.80	5.46	80.72	1.43	1.59	70.86
"	Rustler	Mature	9.55	4.44	82.79	1.77	1.45	72.84
1909	Rustler	Mature	9.56	4.55	82.33	1.41	1.52	70.00
"	Brewers	In milk	9.64	3.97	81.99	2.70	1.70	67.27
1908	Early Mastodon	In milk	9.22	4.62	82.29	2.33	1.54	72.98
1909	Early Mastodon	In milk	9.69	4.36	82.06	2.21	1.68	68.39
1908	Klondike	In milk	10.81	4.40	80.73	2.27	1.79	71.48
"	Red Cob Silage	In milk	10.69	3.61	81.80	2.33	1.57	72.70
"	White Cap Yellow	In milk	10.30	3.93	82.13	2.09	1.55	73.13
1909	White Cap Yellow	In milk	9.06	4.42	82.77	2.24	1.51	69.16
"	Wings Imp. White Cap	In milk	10.21	4.35	81.18	2.52	1.74	67.90

A study of the analytical results shows very slight variations in composition. The protein of the flint varieties is rather in excess of the Rustler Dent. The protein of the coarse less mature dents would probably have been somewhat less had they been more completely matured. The fiber percentage is noticeably less in the mature lots, 1.54 as against 2.34 for the immature types. A high fiber is believed to be characteristic of immature corn. The percentages of starch are remarkably uniform.

While corn has been bred in an experimental way which bore decidedly different chemical characteristics (namely high protein, high starch and high fat) such corn has not come into general use; when, therefore, the grain is grown primarily as a food for stock, it is believed that the farmer can do no better than to grow the variety that will in his experience produce the largest number of bushels of mature corn per acre. This fact is borne out not only by the analyses herein reported but also by others made by the author. Chemical composition cannot, at the present time, be considered a factor in the selection of seed corn where the crop is used for the sustenance of live stock.

An evident effect of the season upon the starch content is shown in the case of Rustler, Early Mastodon and White Cap Yellow, all grown in two successive years. In each case the starch content was slightly lower for 1909, an unfavorably year.

ANALYSIS OF CORN COB.

(Dry Matter).

Year.	Variety.	Condition.	Protein. %	Fat. %	Nitrogen Free Extract. %	Fiber. %	Ash. %
1908	Sanford White	Mature	1.97	0.27	58.21	38.01	1.54
"	Longfellow	Mature	1.98	0.30	59.11	36.91	1.70
"	Rustler	Mature	1.70	0.44	62.15	34.12	1.59
"	Early Mastodon	In milk	1.84	0.32	60.79	35.49	1.56
"	Klondike	In milk	2.21	0.38	61.80	33.86	1.75
"	Red Cob Silage	In milk	2.09	0.38	60.07	35.75	1.75
"	White Cap Yellow Dent	In milk	2.17	0.34	60.08	35.98	1.49
	Average		1.99	0.33	60.32	35.73	1,63

The above analyses represent the product of several varieties of cob produced during the season of 1908. One notes comparatively little variation in the composition. The cob is characterized by its very low protein and fat content and its high extract matter and fiber. It is doubtful if the cob from any number of different varieties would show substantial variations from the figures reported above. Lindsey and Holland[1] have shown the cob to contain over 30 percent of pentosans which have a digestibility of 63 percent and further[2] that the total dry matter of the cob has a digestibility of 59 percent. So far as known, further studies of the chemical character of the extract matter have not been made. It is evident that the chief feeding value of the cob is to be found in its 59 percent of digestible carbohydrates.

On the basis of the work done by Kellner[3], the net available energy in 100 pounds of cob containing 11 percent water is 24.5 Therms, as against 85.5 Therms in a like amount of corn meal or 100 pounds of corn cob has 29 percent of the energy value of corn meal.

The practical feeder, therefore, cannot afford to pay grain prices for the cob when used as an adulterant of wheat mixed feed, hominy meal or the like. Its use, however, is warranted when produced upon the farm and ground together with the kernel as a food for farm animals.

1. Fifteenth Report of the Hatch Experiment Station, pp 78-79.
2. Eighteenth Report of the Hatch Experiment Station, p. 243.
3. Die Ernahrung die Landw. Nutzthiere, fünfte Auflage, pp 159-169, also p. 601.

SUMMARY.

Yield. The small early maturing types of corn are not economical for Massachusetts conditions, the medium dent and flint varieties that will mature in the average season are quite well suited for grain and also serve fairly well for silage. The larger medium dent varieties that in an average season bring their ears to the milk stage are, all conditions considered, rather preferable for silage purposes while the coarse late maturing varieties which never ripen seed in this locality are not satisfactory on account of their failure to mature.

The season has a marked influence upon the yield of the corn crop, the same variety of corn under otherwise identical conditions yielding from 50 to 100 percent more in a year particularly favorably to its growth.

Composition of the Corn Plant. The general conclusion can be drawn that the changes in chemical composition which the plant undergoes in its development are such that its maximum feeding value exists at its maturity.

Digestibility of the Corn Plant. Digestion experiments conducted with the entire corn plant showed no wide variation in the digestibility of the several varieties, the range being from 67 to 77 percent. With one exception, the digestibility appeared to depend upon the percentage of nitrogen free extract. The higher the percentage of extract or starchy matter present, the higher the digestibility.

Proportion and Composition of Parts. The stalks and ears form practically 70 percent of the dry matter of the plant, the

leaves and husks 30 percent.

Relative Proportion of Grain to Cob. The percentage of grain and cob vary widely depending to some extent upon the maturity of the plant when cut. The average for the several mature types was 15.5 percent cob and 84.5 percent kernel, while the average for the less mature varieties was 18.1 percent cob and 81.9 percent kernel. In either case the percentage of cob was less than that allowed by the Massachusetts legal bushel which in the case of shelled corn is 56 pounds and for a bushel of ears 70 pounds, thus allowing 14 pounds or 20 percent for cob.

Composition of Grain and Cob. The grain analyzed showed only slight variations in composition. Chemical composition cannot at the present time be considered a factor in the selection of seed corn where the crop is used for the sustenance of live stock.

There appears to be very little variation in the composition of the corn cob. The net available energy in 100 pounds of cob is 24.5 Therms as against 85.5 Therms in a like amount of corn meal.

SUPPLEMENT.

Figures in Detail for Digestion

Experiments Made with Corn Fodder.

Composition of Feed Stuffs (Per cent)
Dry Matter

Feed Stuffs	Ash	Protein	Fiber	Nitrogen free Extract	Fat
Eureka Silage corn fodder	6.19	9.34	27.41	55.52	1.54

Composition of Feces (Per cent)
Dry Matter

Sheep	Ash	Protein	Fiber	Nitrogen free Extract	Fat
1	9.87	8.77	33.61	46.28	1.41
2	11.47	9.85	31.70	45.30	1.68
3	10.92	9.14	32.41	45.89	1.64

Dry Matter Determinations made at the Time of Weighing out the Different Foods, and Dry Matter in Air-Dry Feces (Per cent)

Eureka corn fodder	Air-dry Feces		
	Sheep 1	Sheep 2	Sheep 3
17.42	89.82	89.93	89.81

Eureka Silage Corn Fodder

Food fed, water drank daily and daily amount of manure excreted

[3400 gms Eureka Silage Corn and 10 gms salt daily]

Date	Sheep I Manure Excreted Daily gms	Sheep I Sample Air Dry gms %	Sheep I Water Drank Daily c.c.	Sheep II Manure Excreted Daily gms	Sheep II Sample Air Dry gms %	Sheep II Water Drank Daily c.c.	Sheep III Manure Excreted Daily gms	Sheep III Sample Air Dry gms %	Sheep III Water Drank Daily c.c.
Sept 26	726	25.90	—	466	18.80	—	487	23.50	—
" 27	547	22.19	—	492	16.61	—	459	22.22	—
" 28	717	24.46	340	557	22.84	1120	504	23.26	885
" 29	465	19.23	—	455	20.52	—	453	20.01	—
" 30	745	25.29	—	496	21.55	—	507	22.20	—
Oct 1	717	27.80	—	504	19.67	—	507	21.88	—
" 2	495	19.83	70	569	24.92	25	448	19.31	—
Average	630	23.529	—	506	20.701	—	481	21.769	—

Weights of Sheep at beginning & end of period

Sheep I Beginning lbs	Sheep I End lbs	Sheep II Beginning lbs	Sheep II End lbs	Sheep III Beginning lbs	Sheep III End lbs
167.50	164.75	156.00	154.50	149.00	145.75

Eureka Silage Corn

	Dry Matter	Ash	Protein	Fiber	Nitrogen Free Extract	Fat
Sheep I						
3400 gms Eureka Silage Corn	592.28	36.66	55.32	162.34	328.83	9.12
235.29 " manure excreted	211.34	20.86	18.53	71.16	97.81	2.98
Grammes digested	380.94	15.80	36.79	91.18	231.02	6.14
Per cent digested	64.32	43.10	66.50	56.17	70.26	67.32
Sheep II						
3400 gms Eureka Silage Corn	592.28	36.66	55.32	162.34	328.83	9.12
207.01 " manure excreted	186.16	21.35	18.34	59.01	84.33	3.13
Grammes digested	406.12	15.31	36.98	103.33	244.50	5.99
Per cent digested	68.57	41.76	66.85	63.65	74.35	65.68
Sheep III						
3400 gms Eureka Silage Corn	592.28	36.66	55.32	162.34	328.83	9.12
217.69 " manure excreted	195.51	21.35	17.87	63.36	89.72	3.21
Grammes digested	396.77	15.31	37.45	98.98	239.11	5.91
Per cent digested	66.99	41.76	67.70	60.97	72.72	64.80
Average for three sheep	66.63	42.21	67.02	60.26	72.44	65.93

1904

Composition of Feed Stuffs (Per cent)
[Dry Matter]

Feed Stuffs	Ash	Protein	Fiber	Nitrogen Free Extract	Fat
Eureka Silage Corn Stover	6.46	8.00	36.49	47.16	1.39
Waste Sheep 2	8.50	6.71	41.89	41.89	1.01
Waste Sheep 3	7.45	6.02	42.84	42.48	1.21

Composition of Feces (Per cent)
[Dry Matter]

Sheep	Ash	Protein	Fiber	Nitrogen Free Extract	Fat
2	7.46	8.75	34.10	48.16	1.03
3	8.61	9.13	30.51	50.05	1.04

Dry matter determinations made at the time of weighing out the different foods, dry matter in waste and Dry Matter in air dry Feces (Per cent)

Eureka Silage Corn Stover	Waste Sheep 2	Waste Sheep 3	Air dry Feces Sheep 2	Air dry Feces Sheep 3
37.11	43.15	45.63	94.16	93.96

Eureka Silage Corn Stover

Sheep II

	Dry Matter	Ash	Protein	Fiber	Nitrogen Free Extract	Fat
1800 gms Eureka silage corn stover	667.98	46.49	53.44	243.75	315.02	9.28
Minus 89 gms waste	38.40	3.26	2.58	16.09	16.09	0.38
Amount consumed	629.58	43.23	50.86	227.66	298.93	8.90
310.74 gms manure excreted	292.59	23.29	25.60	99.77	140.91	3.01
Grammes digested	336.99	19.94	25.26	129.89	158.02	5.89
Per cent digested	53.53	46.13	49.61	56.18	52.86	66.18

Sheep III

1800 gms Eureka silage corn stover	667.98	46.44	53.44	243.15	315.02	9.28
Minus 133.2 gms waste	60.78	4.53	3.66	26.04	25.82	0.74
Amount consumed	607.20	41.96	49.78	217.11	289.20	8.54
289.07 gms manure excreted	271.61	23.55	26.43	82.87	135.94	2.82
Grammes digested	335.59	18.41	23.35	134.84	153.26	5.72
Per cent digested	55.27	43.88	46.91	61.94	52.99	66.98

Average for two sheep	54.40	45.01	48.29	59.06	52.93	66.58

Eureka Silage Corn Stover

Food fed, water drank daily and daily amount of manure excreted

(1800 gms Eureka Silage Corn Stover, 10 gms salt)

Date	Sheep II			Sheep III		
	Manure Excreted Daily gms	Sample Air Dry gms	%	Water Drank Daily cc	Manure Excreted Daily gms	Sample Air Dry gms	%	Water Drank Daily cc
Nov 29	698	28.95		—	853	25.85		1000
" 30	833	32.06		150	929	26.16		500
Dec 1	856	33.95		400	931	28.43		650
" 2	684	29.17		—	882	28.77		—
" 3	747	29.28		—	833	28.62		950
" 4	735	30.81		—	935	31.37		965
" 5	799	33.24		500	1082	32.55		1565
Average	765	31.074		—	921	28.907		804

Waste from Sheep II for 10 days 890 gms

" " Sheep III " " " 1332 "

Weight of sheep at beginning and end of period

Sheep II		Sheep III	
Beginning lbs	End lbs	Beginning lbs	End lbs
156.50	154.00	163.25	163.00

Composition of Feed Stuffs (Per cent)
[Dry Matter]

Feed Stuff	Ash	Protein	Fiber	Nitrogen free Extract	Fat
Pride of the North Corn Stover	6.77	1.23	34.45	50.01	1.54
Waste Sheep 2	7.64	4.27	40.94	45.65	1.50
Waste Sheep 3	6.88	3.76	40.74	47.14	1.48

Composition of Feces (Percent)
Dry Matter

Sheep	Ash	Protein	Fiber	Nitrogen free Extract	Fat
2	9.54	8.81	30.27	50.17	1.21
3	10.62	9.41	27.95	50.84	1.18

Dry matter determinations made at the time of weighing out the different feeds, dry matter in waste and dry matter in air dry feces (Per Cent)

Pride of the North Corn Stover	Waste Sheep 2	Waste Sheep 3	Air dry Feces Sheep 2	Air dry Feces Sheep 3
81.87	88.89	85.63	94.22	94.03

Pride of the North Corn Stover

Food fed, water drank daily and daily amount of manure excreted

(1000 gms Pride of the North Stover 10 gms salt)

Date		Sheep II Manure Excreted Daily gms	Sheep II Sample Air Dry 1/10 gms	Sheep II Water Drank Daily c.c.	Sheep III Manure Excreted Daily gms	Sheep III Sample Air Dry gms	Sheep III Water Drank Daily c.c.
December	29	851	29.53	1100	926	32.65	2500
"	30	1013	37.11	1065	1168	32.86	2500
"	31	1158	43.91	1815	1230	33.74	2500
Jan	1	1000	35.47	1515	1199	35.15	2500
"	2	928	35.63	2310	1168	35.48	2500
"	3	1192	38.79	2070	1167	36.65	2500
"	4	1267	42.98	1675	1000	34.28	2500
Average		1058	37.631	1667	1123	34.401	2500

Waste from Sheep II for 11 days 821 gms

Waste from Sheep III for 11 days 1270 "

Weight of Sheep at beginning & end of period

Sheep II Beginning lbs	Sheep II End lbs	Sheep III Beginning lbs	Sheep III End lbs
154.50	151.00	164.50	161.00

Pride of the North Corn Stover

Sheep II

	Dry Matter	Ash	Protein	Fiber	Nitrogen free Extract	Fat
1000 gms Pride of the North stover	818.70	55.43	59.19	282.04	409.43	12.61
Minus 74.64 gms waste	66.35	5.01	2.83	27.16	30.29	1.00
Amount consumed	752.35	50.36	56.36	254.88	379.14	11.61
376.31 gms manure excreted	354.56	33.83	31.24	107.33	177.88	4.29
Grammes digested	397.79	16.53	25.12	147.55	201.26	7.32
Per cent digested	52.87	32.82	44.57	57.89	53.08	63.05

Sheep III

1000 gms Pride of the North stover	818.70	55.43	59.19	282.04	409.43	12.61
Minus 115.45 gms waste	98.86	6.80	3.72	40.28	46.60	1.46
Amount consumed	719.84	48.63	55.47	241.76	362.83	11.15
344.01 gms manure excreted	323.47	34.35	30.44	90.41	164.45	3.82
Grammes digested	396.37	14.28	25.03	151.35	198.38	7.33
Per cent digested	55.06	29.36	45.12	62.60	54.68	65.75

Average for two sheep	53.97	31.09	44.85	60.25	53.88	64.40

Composition of Feed Stuff (Per cent)
Dry Matter

Feed stuff	Ash	Protein	Fiber	Nitrogen free Extract	Fat
Pride of the North Corn Fodder	5.56	8.83	23.11	60.24	2.26

Composition of Feces (Per Cent)
Dry Matter

Sheep	Ash	Protein	Fiber	Nitrogen free Extract	Fat
2	11.86	11.17	27.55	47.68	1.74
3	12.86	11.18	27.68	46.35	1.93

Dry matter determinations made at the time of weighing out the different feeds and dry matter in air dry feces (Per cent)

Pride of the North Corn fodder	Air dry Feces	
	Sheep 2	Sheep 3
2[illegible].61	89.28	89.09

Pride of the North Corn Fodder

Food fed, water drank daily and daily amount of manure excreted

(3600 gms Pride of the North Corn fodder, 10 gms salt)

Date	Sheep II Manure Excreted Daily gms	Sheep II Sample Air Dry gms 1/10	Sheep II Water Drank Daily c.c	Sheep III Manure Excreted Daily gms	Sheep III Sample Air Dry gms 1/10	Sheep III Water Drank Daily cc
September 13	749	27.61	75	876	25.71	80
" 14	688	28.46	100	960	30.01	100
" 15	512	20.18	125	880	29.07	50
" 16	758	29.37	100	815	28.57	70
" 17	531	22.52	70	658	25.00	35
" 18	581	26.04	30	773	29.75	45
" 19	551	25.18	60	775	28.72	40
Average	624	25.62	80	820	28.12	60

Weight of Sheep at beginning & end of period

Sheep II Beginning lbs	Sheep II End lbs	Sheep III Beginning lbs	Sheep III End lbs
160	154	151.50	150

Pride of the North Corn Fodder

Sheep II

	Dry Matter	Ash	Protein	Fiber	Nitrogen Free Extract	Fat
3600 gms Pride of the North Fodder	813.96	45.26	71.87	188.11	490.33	18.40
256.23 " manure excreted	228.76	27.13	25.55	63.02	109.07	3.98
Grammes digested	585.20	18.13	46.32	125.09	381.26	14.42
Per cent digested	71.89	40.06	64.45	66.50	77.76	78.37

Sheep III

3600 gms Pride of the North Fodder	813.96	45.26	71.87	188.11	490.33	18.40
281.19 " manure excreted	250.51	32.22	28.01	69.34	116.11	4.83
Grammes digested	563.45	13.04	43.86	118.77	374.22	13.57
Per cent digested	69.22	28.81	61.03	63.14	76.32	73.75

Average for two sheep	70.56	34.43	62.74	64.82	77.04	76.06

1906.

Composition of Feed Stuffs (Per cent)
Dry Matter

Feed Stuff	Ash	Protein	Fiber	Nitrogen Free Extract	Fat
Pride of The North Corn Fodder	4.07	7.69	17.96	67.62	2.66
Waste Sheep IV	3.77	8.70	14.28	69.92	3.33

Composition of Feces (Per cent)
Dry Matter

Sheep.	Ash	Protein	Fiber	Nitrogen Free Extract	Fat
II	10.21	11.74	27.77	48.65	1.63
IV	12.89	12.75	24.61	47.65	2.10

Dry matter determinations made at the time of weighing out food, dry matter in waste and dry matter in air dry feces (Per cent)

Pride of the North Fodder	Waste Sheep IV	Air-dry Feces Sheep II	Air-dry Feces Sheep IV
29.50	36.26	89.78	90.19

Pride of the North Corn Fodder

Food fed water drank daily and daily amount of manure excreted

(3600 gms Pride of the North Fodder, 10 gms salt)

Date	Sheep II Manure excreted Daily gms	Sheep II Sample Air Dry gms 1/10	Sheep II Water Drank Daily cc	Sheep IV Manure excreted Daily gms	Sheep IV Sample Air Dry gms 1/10	Sheep IV Water Drank Daily cc
Sept 13	860	26.54	1100	582	18.68	1200
" 14	985	33.04	1300	471	17.60	1235
" 15	885	29.43	880	720	24.22	1005
" 16	918	29.86	900	724	22.25	1190
" 17	1116	35.53	1000	569	17.38	875
" 18	1225	37.16	890	—	—	—
" 19	1068	31.33	490	—	—	—
Average	1008	31.841	937	613	20.026	1101

Waste from Sheep IV 1677 gms last three days of experiment

This sheep went to pieces after 5 days.

Weight of sheep at beginning & end of period

Sheep II Beginning lbs	Sheep II End lbs	Sheep IV Beginning lbs	Sheep IV End lbs
110	111	121.50	116.50

Pride of the North Corn Fodder.

Sheep II

	Dry Matter	Ash	Protein	Fiber	Nitrogen free Extract	Fat
3600 gms Pride of the North fodder	1062.00	43.22	81.67	190.74	718.12	28.25
Minus 318.41 gms manure excreted	285.87	29.19	33.56	79.39	139.08	4.66
Grammes digested	776.13	14.03	48.11	111.35	579.04	23.59
Per cent digested	73.08	32.46	58.91	58.38	80.63	83.50

Sheep IV

3600 gms Pride of the North fodder	1062.00	43.22	81.67	190.74	118.12	28.25
Minus 335.4 gms waste	121.62	4.59	10.58	17.37	85.04	4.05
Amount consumed	940.38	38.63	71.09	173.37	633.08	24.20
Minus 200.26 gms manure excreted	180.61	23.28	23.03	44.45	86.06	3.79
Grammes digested	759.77	15.35	48.06	128.92	547.02	20.41
Per cent digested	80.79	39.74	67.60	74.36	86.41	84.34

Average for two sheep	76.94	36.10	63.26	66.57	83.52	83.92

Composition of feed Stuff (per cent)
[Dry Matter]

Feed Stuff	Ash	Protein	Fiber	Nitrogen free Extract	Fat
Leaming Corn Fodder	4.69	7.89	22.42	62.94	2.06

Composition of feces (Per cent)
Dry Matter

Sheep	Ash	Protein	Fiber	Nitrogen Free Extract	Fat
III	9.67	10.90	28.21	49.49	1.73
V	10.23	10.30	29.40	48.50	1.57

Dry matter determinations made at the time of weighing out the different feeds and dry matter in air dry feces.

Leaming Corn Fodder	Air dry feces Sheep III	Air dry feces Sheep V
24.52	89.92	90.76

Leaming Corn Fodder

Food fed, water drank daily and daily amount of manure excreted.

(3600 gms Leaming Corn fodder, 10 gms salt)

Date		Sheep III Manure Excreted Daily gms	Sheep III Sample Air Dry gms 1/10	Sheep III Water Drank Daily cc	Sheep V Manure Excreted Daily gms	Sheep V Sample Air Dry gms 1/10	Sheep V Water Drank Daily cc
September	13	333	15.05	485	756	23.05	890
"	14	755	29.05	1185	931	26.20	1390
"	15	900	32.95	985	1028	28.21	1185
"	16	913	37.12	1095	1449	35.94	900
"	17	756	28.83	900	1552	36.14	885
"	18	855	28.45	1005	—	—	—
"	19	795	29.05	595	—	—	—
Average		795	28.643	893	1143	29.908	1050

Sheep V went to pieces after 5 days.

Weight of sheep at beginning and end of period

Sheep III Beginning lbs	Sheep III End lbs	Sheep V Beginning lbs	Sheep V End lbs
113.50	125.50	108.00	110.00

Leaming Corn Fodder

Sheep III

	Dry Matter	Ash	Protein	Fiber	Nitrogen Free Extract	Fat
3600 gms Leaming Corn Fodder	882.72	41.40	69.65	197.91	555.58	18.18
Minus 286.43 gms manure excreted	257.56	24.91	28.07	72.66	127.47	4.46
Grammes digested	625.16	16.49	41.58	125.25	428.11	13.72
Per cent digested	70.82	39.83	59.70	63.29	77.06	75.47

Sheep V

3600 gms Leaming Corn Fodder	882.72	41.40	69.65	197.91	55558	18.18
Minus 299.08 gms manure excreted	271.45	27.77	27.96	79.81	131.65	4.26
Grammes digested	611.27	13.63	41.69	118.10	423.93	13.92
Per cent digested	69.25	32.92	59.86	59.67	76.30	76.57

Average for two sheep	70.04	3638	59.78	61.48	7668	76.02

Composition of Feed stuffs (Per cent)
[Dry Matter]

Feed Stuff	Ash	Protein	Fiber	Nitrogen Free Extract	Fat
Rustler White Dent fodder	4.38	6.87	19.46	66.96	2.33
Waste Sheep IV	2.85	3.37	29.12	63.58	1.08

Composition of Feces (Per cent)
[Dry Matter]

Sheep	Ash	Protein	Fiber	Nitrogen Free Extract	Fat
3	9.71	12.07	26.62	49.87	1.67
4	11.17	14.11	25.11	47.61	1.99

Dry matter determinations made at the time of weighing out food dry matter in waste and dry matter in air dry feces

Rustler White Dent fodder	Waste Sheep IV	Air dry feces Sheep III	Air dry feces Sheep IV
31.46	94.05	88.51	88.64

Rustler White Dent Fodder

Food Fed, Water drank daily and daily amount of manure excreted

(2400 gms Rustler White Dent Fodder, 10 gms salt)

Date	Sheep III Manure Excreted Daily gms	Sheep III Sample Air Dry gms 1/10	Sheep III Water Drank Daily cc	Sheep IV Manure Excreted Daily gms	Sheep IV Sample Air Dry gms 1/10	Sheep IV Water Drank Daily cc
September 13	673	11.42	2500	1580	29.40	1200
" 14	753	19.22	2015	1452	25.60	1170
" 15	1005	26.69	1300	1638	30.33	900
" 16	1058	27.26	1195	703	15.70	865
" 17	1095	28.43	2500	1098	24.05	1190
" 18	389	11.80	2500	677	16.65	300
" 19	1531	39.90	1215	1139	27.34	700
Average	929	26.674	1889	1184	24.153	904

Sheep IV 265 gms waste

Weight of Sheep at beginning & end of period

Sheep III Beginning lbs	Sheep III End lbs	Sheep IV Beginning lbs	Sheep IV End lbs
85.5	90	97.0	95

Rustler White Dent fodder

Sheep III

	Dry Matter	Ash	Protein	Fiber	Nitrogen free extract	Fat
2400 gms Rustler fodder	755.04	33.07	51.87	146.93	505.56	17.59
Minus 266.74 gms manure excreted	236.09	23.07	28.50	62.85	117.72	3.93
Grammes digested	518.95	10.00	23.37	84.08	387.84	13.66
Per cent digested	68.73	30.24	45.05	57.22	76.71	77.66

Sheep IV

2400 gms Rustler fodder	755.04	33.07	51.87	146.93	505.56	17.59
Minus 37.86 gms waste	35.61	1.01	1.20	10.37	22.65	0.38
Amount consumed	719.43	32.06	50.67	136.56	482.91	17.21
Minus 241.53 gms manure excreted	214.09	23.91	30.21	53.76	101.95	4.26
Grammes digested	505.34	8.15	20.46	82.80	380.96	12.95
Per cent digested	70.24	25.42	40.38	60.63	78.89	75.20

Average for two sheep	69.49	27.83	42.72	58.93	77.80	76.46

Composition of Feed Stuff (Per cent)
Dry Matter

Feed Stuff	Ash	Protein	Fiber	Nitrogen free Extract	Fat
Early Mastodon Corn Fodder	4.31	7.38	19.40	66.74	2.17

Composition of Feces (Per cent)
Dry Matter

Sheep	Ash	Protein	Fiber	Nitrogen free Extract	Fat
I	9.52	11.12	27.34	50.57	1.45
II	10.16	11.41	27.70	49.17	1.56

Dry matter determinations made at the time of weighing out food and dry matter in air dry feces.

Early Mastodon Corn Fodder	Air dry feces Sheep I	Air dry feces Sheep II
24.80	89.08	88.92

Early Mastodon Dent fodder

Food fed, Water Drank Daily and Daily Amount of Manure Excreted

(2400 gms Early Mastodon Dent fodder, 10 gms salt)

Date	Sheep I Manure Excreted Daily gms	Sheep I Sample Air Dry gms %	Sheep I Water Drank Daily cc	Sheep II Manure Excreted Daily gms	Sheep II Sample Air Dry gms %	Sheep II Water Drank Daily c.c
September 13	500	17.12	800	745	19.61	425
" 14	470	15.74	750	865	19.55	150
" 15	561	17.36	50	982	23.39	350
" 16	690	19.99	300	542	15.04	790
" 17	600	18.74	75	677	17.37	260
" 18	708	21.67	340	697	21.73	340
" 19	628	19.13	510	621	16.24	600
Average	594	18.621	404	733	18.990	416

Weight of sheep at beginning & end of period

Sheep I Beginning lbs	Sheep I End lbs	Sheep II Beginning lbs	Sheep II End lbs.
89.0	89.0	86.5	86

Early Mastodon Dent fodder

Sheep I

	Dry Matter	Ash	Protein	Fiber	Nitrogen free Extract	Fat
2400 gms Early Mastodon fodder	595.20	25.67	43.93	115.47	397.21	12.92
Minus 186.21 gms manure excreted	165.88	15.79	18.45	45.35	83.88	2.41
Grammes digested	429.32	9.88	25.48	70.12	313.33	10.51
Per cent digested	72.13	38.49	58.00	60.73	78.88	81.35

Sheep II

2400 gms Early Mastodon fodder	595.20	25.67	43.93	115.47	397.21	12.92
Minus 189.40 gms manure excreted	168.86	17.16	19.27	46.77	83.03	2.63
Grammes digested	426.34	8.51	24.66	68.70	314.18	10.29
Per cent digested	71.63	33.15	56.18	59.50	79.10	79.64

Average for two sheep	71.88	35.82	57.07	60.12	78.99	80.50

Composition of Feed stuff. (Per cent)
Dry Matter

Feed stuff	Ash	Protein	Fiber	Nitrogen Free Extract	Fat
Brewers Dent Corn Fodder	5.32	9.84	23.94	59.40	1.50

Composition of Feces (Per cent)
Dry Matter

Sheep	Ash	Protein	Fiber	Nitrogen Free Extract	Fat
I	10.00	11.27	25.93	51.17	1.63
II	10.50	10.87	27.75	49.08	1.80

Dry matter determinations made at the time of weighing out food and dry matter in air dry feces. (Per cent)

Brewers Dent Corn Fodder	Air dry feces Sheep I	Air dry feces Sheep II
19.34	89.59	89.71

Brewers Dent Corn Fodder

Food Fed, water drank daily and daily amount of manure excreted

(2500 gms Brewers Dent fodder, 10 gms salt

Date	Sheep I Manure Excreted Daily gms	Sheep I Sample Air Dry 1/5 gms	Sheep I Water Drank Daily c.c.	Sheep II Manure Excreted Daily gms	Sheep II Sample Air Dry 1/5 gms	Sheep II Water Drank Daily cc
September 13	400	30.27	250	310	22.73	500
" 14	510	30.18	500	432	32.30	350
" 15	355	21.89	350	375	29.26	25
" 16	358	21.21	120	455	35.62	10
" 17	395	24.96	500	425	32.79	140
" 18	418	33.62	15	489	36.85	50
" 19	391	31.32	100	361	26.83	490
Average	403	29.201	262	407	30.911	224

Weight of sheep at beginning & end of period

Sheep I Beginning lbs	Sheep I End lbs	Sheep II Beginning lbs	Sheep II End lbs
94.5	93.0	95.0	93.0
94.5	93.5	95.5	93.0

Brewers Dent fodder

Sheep I

	Dry Matter	Ash	Protein	Fiber	Nitrogen free Extract	Fat
2500 gms Brewers dent fodder	484.75	25.79	47.70	116.05	281.94	7.27
Minus 146.04 gms manure excreted	130.84	13.08	14.75	33.93	66.95	2.13
Grammes digested	353.91	12.71	32.95	82.12	220.99	5.14
Per cent digested	73.01	49.28	69.08	70.76	76.75	70.70

Sheep II

2.500 gms Brewers dent fodder	484.75	25.79	47.70	116.05	287.94	7.27
Minus 154.56 gms manure excreted	138.66	14.56	15.07	38.48	68.05	2.50
Grammes digested	346.09	11.23	32.63	77.57	219.89	4.77
Per cent digested	71.40	43.54	68.41	66.84	76.37	65.61

Average for two sheep	72.21	46.41	68.75	68.80	76.56	68.16

Composition of Feedstuff (Per cent)
Dry matter.

Feedstuff	Ash	Protein	Fiber	Nitrogen free Extract	Fat
Wings Improved White Dent Fodder	4.85	9.36	22.58	61.64	1.57

Composition of Feces (Per cent)
Dry Matter

Sheep	Ash	Protein	Fiber	Nitrogen free Extract	Fat
III	9.96	11.66	28.33	48.54	1.51
IV	9.99	11.73	25.08	51.55	1.65

Dry matter determination made at the time of weighing out food and dry matter in our dry feces (Per cent)

Wings Imp. White Dent Fodder	Our dry Feces Sheep III	Sheep IV
19.18	89.17	89.72

Wings Improved White Dent Corn Fodder

Food fed water drank daily and daily amount of manure excreted

(2500 gms Wings Improved Dent fodder, 10 gm salt)

Date		Sheep III Manure Excreted Daily gms	Sheep III Sample Air Dry 1/5 gms	Sheep III Water Drank Daily c.c.	Sheep IV Manure Excreted Daily gms	Sheep IV Sample Air Dry 1/5 gms	Sheep IV Water Drank Daily c.c.
September	13	465	30.70	150	165	15.63	50
"	14	462	31.43	50	360	32.27	75
"	15	559	32.48	400	302	28.52	25
"	16	653	34.01	30	505	40.67	180
"	17	567	30.93	90	446	34.35	100
"	18	585	34.76	350	370	31.25	75
"	19	626	32.60	30	458	35.08	160
Average		560	32.416	157	372	31.110	95

Weights of Sheep at beginning & end of period

Sheep III Beginning lbs	Sheep III End lbs	Sheep IV Beginning lbs	Sheep IV End lbs.
78.5	78.0	107.5	107.5
78.5	77.5	108.0	106.0

Wings Improved White Dent Corn Fodder

Sheep III

	Dry Matter	Ash	Protein	Fiber	Nitrogen Free Extract	Fat
2500 gms corn fodder	479.50	23.26	44.88	108.28	295.56	7.52
Minus 162.08 gms manure excreted	144.53	14.40	16.85	40.95	70.15	2.18
Grammes digested	334.97	8.86	28.03	67.33	225.41	5.34
Per cent digested	69.86	38.09	62.46	62.18	76.27	71.01

Sheep IV

2500 gms corn fodder	479.50	23.26	44.88	108.28	295.56	7.52
Minus 155.55 gms manure excreted	139.56	13.94	16.37	35.00	71.95	2.30
Grammes digested	339.94	9.32	28.51	73.28	223.61	5.22
Per cent digested	70.89	40.07	63.52	67.68	75.66	69.41

Average for two sheep	70.38	39.08	62.99	64.93	75.97	70.21